VS/GR BK/ Library

NATIONAL RADIO ASTRONOMY OBSERVATORY

Quarterly Report

April 1, 1990 - June 30, 1990

TABLE OF CONTENTS

A. TELESCOPE USAGE 1

B. 140-FOOT OBSERVING PROGRAMS 1

C. 12-METER TELESCOPE 6

D. THE VERY LARGE ARRAY 8

E. SCIENTIFIC HIGHLIGHTS 19

F. PUBLICATIONS 21

G. CENTRAL DEVELOPMENT LABORATORY 21

H. GREEN BANK ELECTRONICS 22

I. 12-METER ELECTRONICS 24

J. VLA ELECTRONICS 25

K. AIPS 27

L. VLA COMPUTER 28

M. VERY LONG BASELINE ARRAY 28

N. PERSONNEL 31

APPENDIX A: NRAO PREPRINTS

A. TELESCOPE USAGE

The NRAO telescopes have been scheduled for research and maintenance in the following manner during the second quarter of 1990.

	140-foot	12-meter	VLA
Scheduled observing (hrs)	1826.50	1808.50	1679.3
Scheduled maintenance and equipment changes	141.7	77.25	262.9
Scheduled tests and calibrations	169.75	259.25	246.8
Time lost	96.50	171.25	136.0
Actual observing	1730.0	1637.25	1543.3

B. 140-FOOT OBSERVING PROGRAMS

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
B492	Bell, M. (Herzberg) Feldman, P. (Herzberg) Matthews, H. (Herzberg)	Spectral survey over the range 22.0-24.5 GHz of IRC+10216.
B493	Bania, T. (Boston) Rood, R. (Virginia) Wilson, T. (MPIfR)	Measurements at 8.666 GHz of the $^3He^+$ abundances in the interstellar medium.
B533	Bell, M. (Herzberg) Seaquist, E. (Toronto)	Observations at 18 cm to examine the dust lane and nuclear region of Cent A.
C257	Clark, F. (AFGL) Mann, P. (Kentucky) LaHaise, W. (Kentucky) Laureijs, R. (JPL)	Observations of 2 cm H_2CO in infrared objects.
C259	Clark, F. (AFGL) Wootten, H. A.	Zeeman measurements at 13 GHz of SO in dense star-forming cores.
J121	Jura, M. (UCLA) Kroto, H. (Sussex)	Search at 13.3 GHz for carbon chain molecules around carbon rich planetary nebulae.

No.	Observer(s)	Program
K327	Kulkarni, S. (Caltech) Johnston, H. (Caltech) Anderson, S. (Caltech) Deich, W. (Caltech) Prince, T. (Caltech)	Search at discrete frequencies over the range 800-820 MHz for pulsars in globular clusters.
L220	Lubowich, D. (Hofstra) Turner, B. Hobbs, L. (Yerkes)	Search at 803.5 MHz for ^{7}Li (lithium) in the Galactic Center.
L238	Lee, Y. (Leiden) Greenberg, J. (Leiden) Minn, Y. (Kyung Hee, Korea)	Study of H_2CO at 2 cm to compare with CO data to establish dust correlation in dense dark clouds.
L243	Landecker, T. (DRAO) Anderson, M. (Alberta) Routledge, D. (Alberta) Vaneldik, J. (Alberta) Lockman, F. J.	Search at 4.874 GHz for recombination lines from S183.
L244	Lockman, F. J.	Search at 4.874 GHz for low surface brightness HII regions.
L251	Clark, F. (AFGL) Laureijs, R. (JPL)	Measurements at 4829 MHz of H_2CO in IRAS sources to determine the relationship between dust temperature and molecular abundance.
L253	Liszt, H.	Recombination line observations over the range 18-20 GHz to map Sgr C and studies of carbon recombination lines toward Zeta Oph.
M284	Madden, S. (Massachusetts) Brown, R. (Monash Univ.) Godfrey, P. (Monash Univ.) Henkel, C. (MPIfR) Irvine, W. (Massachusetts) Wilson, T. (MPIfR) Maddalena, R.	Time variability study at 1.5 cm of ammonia masers.
M306	Magnani, L. (Arecibo) Larosa, T. (Alabama) Kassim, N. (NRL)	Observations at 4.830 GHz to determine the prevalence of high density cores in MBM 07 and MBM 16.
M309	Mutel, R. (Iowa) Allen, J. (Iowa)	Survey of the galactic plane for 18 cm OH masers, and confirmation of three newly discovered OH masers that are coincident with IRAS sources.

No.	Observer(s)	Program
S340	Schloerb, F. (Massachusetts) Tacconi-Garman, L. (Massachusetts) Claussen, M. (NRL)	Observations at mainline 18 cm frequencies toward Comet Austin.
T272	Turner, B. Rickard, L. J (NRL) Lanping, X. (Beijing)	Studies at 2 cm of H_2CO in cirrus clouds.
T278	Turner, B. DeFrees, D. (Mol. Res. Inst.) MacLean, A. (Mol. Res. Inst.)	Observations at 19 GHz to confirm the possible detection of C_{50}.
W280	Wootten, H. A.	H_2O monitoring in star forming cores in ρOph.

The following pulsar programs were conducted during this quarter.

No.	Observer(s)	Program
B484	Backer, D. (Berkeley) Foster, R. (Berkeley)	Timing observations at 750-800 MHz and at 1330 MHz of PSR 1821-24 and other millisecond pulsars.
T265	Taylor, J. (Princeton) Stinebring, D. (Princeton) Dewey, R. (JPL) Nice, D. (Princeton) Thorsett, S. (Princeton) Arzoumanian, Z. (Princeton)	Pulsar timing observations over the range 390-450, 800, and 1355 MHz.
T280	Taylor, J. (Princeton) Fruchter, A. (DTM) Stinebring, D. (Princeton) Nice, D. (Princeton) Thorsett, S. (Princeton)	Studies at 18, 21, and 40 cm of the eclipsing millisecond pulsar in Terzan 5.

The following very long baseline programs were conducted, and the stations used for the observations are coded as follows:

A - Arecibo 1000 ft
B - Effelsburg, MPIfR 100 m
Dm - Goldstone DSS14 64 m
Ds - Madrid DSS63 64 m
E - Hartebeesthoek, South Africa 26 m
F - Fort Davis 85 ft
H - Hat Creek 26 m
G - Green Bank 140 ft
Km - Haystack 120 ft
Kp- Kitt Peak 25 m
Lm - Medicini, Italy 25 m
N - NRL Maryland Pt. 85 ft
No - Noto, Sicily
O - Owens Valley 130 ft
Pt - Pietown 25 m
R - Crimea, USSR 30 m
Sa - Shanghai 25 m
Sn - Onsala 20 m
Wn - Westerbork n=1-14x26
Yn - Socorro n=1-27x25 m

No.	Observer(s)	Program
AH51V	Niell, A. (Haystack)	Observations at 3.6 cm to find a reference source for observing AE Aquari, with telescopes O, G, and Pt.
C58V	Cohen, M. (Caltech) Unwin, S. (Caltech) Vermeulon, R. (Caltech) Wehrle, A. (Caltech)	Studies at 6 cm of the statistics of superluminal sources, with telescopes B, Lm, Sn, Wn, No, Km, G, F, O, H, Yl, Kp, Pt, E, and A.
G64V	Giovannini, G. (Bologna) Comoretto, G. (Arcetri) Feretti, L. (Bologna) Venturi, T. (Bologna) Vermeulen, R. (Caltech) Wehrle, A. (Caltech)	Observations at 6 cm of a complete sample of radio galaxies, with telescopes B, Sn, Lm, Wn, No, Km, G, O, Y27, Kp, and Pt.
G66V	Gabuzda, D. (JPL) Cawthorne, T. (CFA)	Linear polarization measurements at 3.6 cm of BL Lac objects, with telescopes B, Lm, Sn, Km, F, G, O, H, Y27, Kp, and Pt.
H53V	Hewitt, J. (MIT) Cappallo, R. (Haystack) Lestrade, J-F. (JPL) Lonsdale, C. (Haystack) Niell, A. (Haystack) Phillips, R. (Haystack) Preston, R. (JPL)	Studies at 3.6 cm of dMe stars, with telescopes B, G, Y27, Dm, and Ds.
H54V	van der Hucht, K. (Utrecht) de Bruyn, A. (NFRA) Spoelstra, T. (NFRA) Williams, P. (Edinburgh)	Imaging at 6 cm of the variable radio emission in the Wolf-Ray binary WR140, with telescopes B, Wn, Sn, Lm, Km, G, O, Y27, Kp, and Pt.
H56V	Hummel, C. (MPIfR) Krichbaum, T. (MPIfR) Quirrenbach, A. (MPIfR) Witzel, A. (MPIfR) Ott, M. (MPIfR) Johnston, K. (NRL)	Studies at 6 cm of the hydrodynamics of the parsec scale jet in 0836+71, with telescopes B, Wn, Sn, Lm, No, R, Km, G, F, O, H, Kp, and Pt.
L59V	Lestrade, J-F. (JPL) Gabuzda, D. (JPL) Preston, R. (JPL) Phillips, R. (Haystack)	Phase referenced observations at 6 cm of RS CVn stars, with telescopes B, Lm, Km, G, O, and Y27.

No.	Observer(s)	Program
M109V	Marcaide, J. (Astrofisica, Spain) Elosegui, P. (IAA, Granada) Shapiro, I. (MIT)	Measurements at 3.6 cm to ascertain whether 1038+528A exhibits core jitter or proper motion, with telescopes B, Sn, Lm, Km, G, F, O, Kp, Pt, and Ds.
M111V	Mutel, R. (Iowa) Jie, D. (Iowa) Phillips, R. (Haystack)	Monitor at 3.6 cm the core of BL Lac, with telescopes B, Sn, Lm, No, Km, G, O, H, F, Y1, Kp, Pt, and Sa.
M113V	Mantovani, F. (Bologna) Junor, W. Padriella, L. (Bologna) Nicolson, G. (Hartebeesthoek)	Observations at 6 cm of three compact, steep spectrum, low-frequency sources, with telescopes Sn, Wn, N, R, and E.
M114V	Zhang, Y. F. (Boston) Shaffer, D. (Interferometrics) Marcaide, J. (Astrofisica, Spain) Alberdi, A. (MPIfR) Elosegui, P. (IAA, Granada)	Observations at 1.3 and 3.6 cm of superluminal 4C 39.25, with telescopes B, Sn, Lm, No, Km, G, O, Y1, Kp, and Pt.
M115V	Molnar, L. (Iowa) Mutel, R. (Iowa)	Interstellar scattering at 6 cm in the direction of Cyg OB2, No. 9, with telescopes G, O, and Y27.
P98V	Pearson, T. (Caltech) Readhead, A. (Caltech)	Second epoch maps at 6 cm of four extended sources, with telescopes B, Lm, Sn, Lm, Km, G, O, Y27, Kp, and Pt.
P102V	Pauliny-Toth, I. (MPIfR) Porcas, R. (MPIfR) Zensus, A.	Observations at 6 cm of a superluminal feature in 3C 454.3, with telescopes B, Lm, Sn, Wn, No, Km, G, F, O, H, Kp, Pt, and E.
P104V	Porcas, R. (MPIfR)	Continued observations at 3.6 cm of 3C 179, with telescopes B, Lm, Sn, Km, G, O, Y27, and Kp.
P105V	Porcas, R. (MPIfR)	Third epoch observations at 6 cm of CTD 93, with telescopes B, Sn, Lm, No, Km, G, O, Y27, and Kp.
R53V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Ochs, M. (Brandeis) Wardle, J. (Brandeis) Cawthorne, T. (CFA) Gabuzda, D. (JPL)	Polarization measurements at 3.6 and 6 cm of 3C 345, with telescopes B, Lm, Wn, Km, G, F, O, H, Y27, Kp, and Pt.

No.	Observer(s)	Program
R54V	Roberts, D. (Brandeis) Brown, L. (Brandeis) Ochs, M. (Brandeis) Wardle, J. (Brandeis) Cawthorne, T. (CfA) Gabuzda, D. (JPL)	Polarization measurements at 3.6 and 6 cm of 3C 273, with telescopes B, Lm, Wn, Km, G, F, O, H, Y27, Kp, and Pt.
S86V	Sakurai, T. (Iowa) Spangler, S. (Iowa) Cairns, I. (Iowa) Mutel, R. (Iowa) Armstrong, J. (JPL)	Reference observations at 6 cm for VLB studies of density turbulence in outer solar corona, with telescopes Km, G, F, O, H, and Pt.
W57V	Wehrle, A. (Caltech)	Monitor at 1.3 cm superluminal motion in 3C 345, with telescopes B, Sn, Lm, No, Km, G, O, Y1, Kp, and Pt.
Z24V	Zhang, Y. (Boston) Baath, L. (Onsala) Rantakyro, F. (Onsala) Chu, H. (Nanjing)	Observations at 1.35 cm of 0735+178, with telescopes B, Sn, Lm, No, Km, G, O, and Pt.

C. 12-METER TELESCOPE

The following line programs were conducted during this quarter.

No.	Observer(s)	Program
A96	Andr\, P. Leous, J. (Penn State) Montmerle, T. (Saclay, France) Cabrit, S. (Saclay, France)	Extensive search for outflows around low-luminosity young stellar objects in L1495.
A97	Andr\, P. Cabrit, S. (Saclay, France) Edwards, S. (Massachusetts) Bertout, C. (Paris)	Study of molecular flows and wind cavities around T Tauri stars.
A99	Andr\, P. Loren, R. (Unaffiliated) Wootten, H. Despois, D. (Bordeaux Obs.)	Search for condensations in the rho Ophiuchi cloud core A.
B528	B__th, L. (Onsala, Sweden) Padin, S. (Caltech) Wright, M. (Berkeley) Rogers, A. (Haystack)	Millimeter VLBI observations of compact radio sources.

No.	Observer(s)	Program
B532	Black, J. (Arizona) van Dishoeck, E. (Caltech)	Study of chemistry and structure of the IC 63 nebula.
C262	Clancy, R. (Colorado) Muhleman, D. (Caltech)	CO/temperature studies of Venus and Mars.
D165	Dent, W. (Massachusetts) Balonek, T. (Colgate)	Study of the evolution of extragalactic radio sources at millimeter wavelengths.
G311	Gordon, M. Martin-Pintado, J. (Yebes Obs.)	Monitoring program for the RRL maser in MWC 349.
G313	Gordon, M. Walmsley, C. M. (MPIfR)	Study of RRL lines as probes of ionization fronts in HII regions.
G315	Green, D. (DRAO) Dewdney, P. (DRAO)	Further observations of HCO^+ associated with G33.6+0.1.
H268	Henkel, C. (MPIfR) Sage, L. (MPIfR) Mauersberger, R. (IRAM)	Study of oxygen isotope ratios in extragalactic nuclei.
H269	Henkel, C. (MPIfR) Sage, L. (MPIfR) Salzer, J. (KPNO)	Study of molecular gas in BCD's.
H270	Hurt, R. (UCLA) Turner, J. (UCLA)	CO (1-0) and CO (2-1) mapping of the starburst galaxy Maffei 2.
H271	Hollis, J. M. (GSFC) Jewell, P.	Spectral line observations of Comet Austin ($1989c_1$).
K328	Kutner, M. (RPI) Verter, F. (GSFC) Mizuno, D. (RPI)	CO J=1-0 studies of M31.
L245	Li, G. (Toronto) Seaquist, E. (Toronto)	CO J=1-0 mapping of early-type galaxies.
L248	Ladd, E. (CFA) Fuller, G. (CFA) Myers, P. (CFA)	$C^{18}O$ mapping of intermediate mass star formation regions.
M308	Maizels, C. (UCLA) Turner, J. (UCLA)	Study of CO in the nucleus of M31.
R242	Rickard, L. J (NRL) Verter, F. (GSFC) Turner, B.	Tracing the structure and kinematics of the molecular component in the unusual infrared cirrus cloud MBM53.

No.	Observer(s)	Program
R244	Reach, W. (Berkeley) Heiles, C. (Berkeley) Koo, B. (Berkeley)	Study of the structure of an interstellar cloud.
R245	Roberts, M. Hogg, D. Bregman, J. (Michigan)	CO observations of interesting early-type galaxies.
S326	Szczepanski, J. (MIT) Ho, P. (CFA)	Study of gas feeding of the galactic center region.
S336	Schombert, J. (Michigan) Barsony, M. (Berkeley)	Study of CO emission in Malin-1 prototype galaxies.
S337	Sage, L. (MPIfR) Henkel, C. (MPIfR) Wiklind, T. (Onsala)	A search for CO emission from an Sb0 galaxy with counter-rotating gas and stars.
T275	Turner, B. Lubowich, D. (Hofstra)	Confirmation of D_2CO and NHD_2 in Orion: A test of grain theories.
T276	Turner, B. Steimle, T. (Arizona State)	A search for interstellar CaH.
T283	Turner, B.	Study of ortho/para ratios to ascertain gas/grain interactions.
W275	Womack, M. (Arizona State) Ziurys, L. (Arizona State) Wyckoff, S. (Arizona State)	Study of nitrogen abundance in the ISM and constraints on conditions in the primitive solar nebula.
W278	Walker, C. (Arizona) Martin, R. (Arizona)	Study of the extended CS emission in IR luminous galaxies.
W281	Wootten, H. A. Loren, R. (Unaffiliated)	Study of origins of non-shock SO_2 around young stars.
Z85	Ziurys, L. (Arizona State)	Searches for interstellar MgS and CaS.
Z87	Ziurys, L. (Arizona State) McGonagle, D. (Massachusetts)	A renewed search for interstellar PO.

D. THE VERY LARGE ARRAY

Second quarter, 1990 was spent in the following configurations:

A configuration from: April 1 to May 3
AB configuration from: May 3 to June 30

The following research programs were conducted with the VLA during this quarter.

No.	Observer(s)	Program
AA108	Anderson, M. (Minnesota)	The time evolution of SNR Cassiopeia A. 6 and 20 cm.
AA109	Abraham, R. (Oxford) McHardy, I. (Oxford) Lehto, H. (Oxford) Crawford, C. (Oxford)	Optical jet in the BL Lac 0Q530. 6 and 20 cm.
AA110	Akujor, C. (Nigeria) Pramesh Rao, A. (Kapteyn Lab)	1912-172-a flat spectrum double source? 2, 3.5, 6 and 20 cm.
AA113	Allen, J. (Iowa) Mutel, R. (Iowa)	Three new OH/IR stars. 18 cm line.
AB414	Becker, R. (Calif., Davis) White, R. (STScI)	Monitoring radio stars HD193793 and P Cygni. 2 and 6 cm.
AB456	Burke, B. (MIT) Hewitt, J. (MIT) Roberts, D. (Brandeis)	Monitoring lens 0957+561. 6 cm.
AB457	Brown, A. (Colorado) Bookbinder, J. (CfA)	Parallax of T Tauri. 2 and 6 cm.
AB534	Baum, S. (NFRA) Leahy, P. (NRAL) Perley, R. Riley, J. (MRAO) Scheuer, P. (MRAO)	A survey of nearby hotspots. 3.8 cm.
AB535	Burke, B. (MIT) Hewitt, J. (MIT) Turner, E. (Princeton) Heflin, M. (MIT)	Ring candidate MG0414+0534. 1.3, 2, 3.8 and 6 cm.
AB559	Backer, D. (Berkeley) Fairhead, L. (Berkeley)	Pulsar astrometry: comparing VLA, VLBI, and timing techniques. 20 cm.
AB562	Barvainis, R. (Haystack) Antonucci, R. (Calif., Santa Barbara)	A new continuum spectral component in radio quiet quasars. 2 and 6 cm.

No.	Observer(s)	Program
AB567	Bowers, P. (NRL) Johnston, K. (NRL)	OH masers from OH53.6-0.2 and IRC-30308. 20 cm line.
AB568	Burke, B. (MIT) Hewitt, J. (MIT) Turner, E. (Princeton) Conner, S. (MIT) Heflin, M. (MIT) Lehar, J. (MIT)	Gravitational lens survey. 3.8 cm.
AC237	Cordova, F. (Penn State) Hjellming, R.	Radio astrometry of PSR 0656+14. 20 cm.
AC256	Captetti, S. (Torino U.) Ferrari, A. (Torino U.) Massaglia, S. (Torino U.) Trussoni, E. (Torino U.) Morganti, R. (Bologna) Fanti, R. (Bologna) Parma, P. (Bologna) de Ruiter, H. (Bologna)	Knots in low-luminosity radio galaxy jets. 6 cm.
AC265	Claussen, M. (NRL) Johnston, K. (NRL) Bowers, P. (NRL)	Absolute positions of the OH masers in IK Tau. 6 and 20 cm line.
AC266	Coles, W. (Calif., San Diego) Rickett, B. (Calif., San Diego) Cornwell, T. Hankins, T. (NMIMT) Armstrong, J. (JPL)	Intensity scintillation and angular scattering of the inner solar wind. 3.8, 6 and 20 cm.
AC267	Condon, J. Kellermann, K. Hazard, C. (Pittsburgh) McMahon, R. (Toronto) Kayser, R. (Toronto)	The "Clover Leaf" quasar H1413+117. 3.8 cm.
AC269	Cordes, J. (Cornell) Weisberg, J. (Carleton College) Backer, D. (Berkeley) Foster, R. (Berkeley) Lundgren, S. (Cornell)	Astrometry of weak pulsars. 20 cm.

No.	Observers	Program
AC270	Cowan, J. (Oklahoma) Branch, D. (Oklahoma)	Intermediate age supernovae 1957D and 1950B in M83. 20 cm.
AC271	Curiel, S. (CFA) Rodriguez, L. (UNAM) Canto, J. (UNAM) Tereby, S. (Caltech)	Radio sources associated with outflows. 3.8 cm.
AD188	Drake, S. (SASC) Simon, T. (Hawaii) Florkowski, D. (USNO) Stencel, R. (Colorado) Bookbinder, J. (CFA)	Variability of M supergiants: alpha Orionis. 2 and 6 cm.
AD243	de Pater, I. (Berkeley)	Neptune. 20 cm.
AD244	Dey, A. (Berkeley) van Breugel, W. (LLNL)	Images of radio-loud, far-infrared galaxies. 2, 6, and 20 cm.
AD245	Dickel, J. (Illinois) Cowan, J. (Oklahoma) Crane, P.	SN1885 in M31. 3.8 cm.
AD246	Dickey, J. (Minnesota) Kazes, I. (Meudon) Mirabel, I. (Puerto Rico)	02483+4302: a galaxy with a megamaser and a background quasar. 1.3, 3.8, 6, and 20 cm line.
AD250	Dulk, G. (Colorado) Lecacheux, A. (Meudon) Louarn, P. (Meudon) Zarka, P. (Meudon) Altenhoff, W. (MPIfR)	AE Aquarii and flare stars. 2, 3.8, and 6 cm.
AD257	Drake, S. (SASC) Caillault, J. (Georgia) Simon, T. (Hawaii) Linsky, J. (Colorado)	Quiescent emission of cool dwarfs. 3.5 cm.
AE065	Elias, N. (Pennsylvania) Dorren, J. (Pennsylvania)	A detection experiment for HD 129333, a "Young Sun." 2, 3.6, 6, and 20 cm.
AE066	Engels, D. (Hamberger Sternwarte) Winnberg, A. (Onsala) Lindqvist, M. (Onsala) Walmsley, C. M. (MPIfR) Schmid-Burgk, J. (MPIfR)	Water maser emission in circumstellar shells. 1.3 cm line.
AE067	Erickson, W. (Tasmania) Jacobson, A. (Los Alamos)	Ionospheric structure. 90 cm.

No.	Observer(s)	Program
AF177	Felli, M. (Arcetri) Churchwell, E. (Wisconsin)	Nonthermal emission from Theta Ori A. 2 and 3.8 cm.
AF180	Fey, A. (NRL) Spangler, S. (Iowa)	Enhanced interstellar scattering due to HII regions. 6 and 20 cm.
AF186	Fernini, I. (New Mexico State) Burns, J. (New Mexico State) Bridle, A. Perley, R.	Jet/counterjet ratios in RGs. 6 cm.
AF188	Feretti, L. (Bologna) Bettoni, D. (Padova) Galletta, G. (Padova) Giovannini, G. (Bologna)	Galaxies with kinematical evidence of recent mergers. 20 cm.
AF189	Fomalont, E. Geldzahler, B. (ARC) Cohen, N. (Boston)	Sco X-1: variations. 6 cm.
AF191	Fomalont, E. Goss, W. M. Lyne, A. (NRAL) Manchester, R. (CSIRO)	Search for VLBI phase reference sources and imaging of selected pulsar fields. 2, 3.8, 6, and 20 cm.
AF192	Fomalont, E. Kellermann, K. Windhorst, R. (Arizona State) Kristian, J. (Mt. Wilson)	1" resolution of the deep radio survey field. 6 cm.
AF193	Fruchter, A. (DTM) Goss, W. M.	Globular clusters with radio sources. 20 cm.
AF197	Feretti, L. (Bologna) Giovannini, G. (Bologna)	Cluster radio galaxies of small size. 6 and 20 cm.
AF200	Frail, D. van Langevelde, H. (Leiden) Habing, H. (Leiden) Cordes, J. (Cornell)	OH/IR stars in the bulge of the galaxy. 18 cm line.
AG303	Gaume, R. (NRL) Johnston, K. (NRL) Wilson, T. (MPIfR)	The dynamics of NGC 7538 IRS 1. 1.3 cm line.
AG307	Goudfrooij, P. (Amsterdam) van Driel, W. (Amsterdam) de Jong, T. (Amsterdam)	Compact core of the peculiar elliptical galaxy IC 1459. 2 and 6 cm.

No.	Observer(s)	Program
AG308	Gopal Krishnan (TIFR) Steppe, H. (IRAM) Subrahmanya, C. (TIFR) Swarup, G. (TIFR)	Ultra-steep spectrum radio sources. 20 cm.
AG313	Giovannini, G. (Bologna) Feretti, L. (Bologna) Ge, J. (NMIMT) Owen, F.	Core of the radio galaxy 3C 338. 6 cm.
AH295	Habing, H. (Leiden) Goss, W. M. Winnberg, A. (Onsala) van Langevelde, H. (Leiden)	Monitoring OH/IR stars at the galactic center. 20 cm line.
AH388	Hines, D. (Texas) Wills, B. (Texas)	Radio structure of extreme IR dominated galaxy IRAS 09104+4109. 3.8 and 20 cm.
AH390	Hjellming, R. Gehrz, R. (Minnesota) Taylor, A. (Calgary) Seaquist, E. (Toronto)	Resolving radio novae. 3.8, 6 and 20 cm.
AH391	Ho, P. (Harvard) Rengarajan, T. (TIFR)	Extremely compact HII regions. 2 and 3.8 cm.
AH392	Holdaway, M. Brown, L. (Brandeis) Kollgaard, R. (Lafayette)	High resolution, high dynamic range map of 3C 273. 2 cm.
AH397	Hughes, V. (Queen's Univ.)	Variability of HII regions in Cepheus A. 2, 6, and 20 cm.
AH399	Hummel, E. (NRAL)	Central radio sources in edge-on galaxies. 3.8 and 6 cm.
AI039	Irwin, J. (Herzberg) Baan, W. (Arecibo) Sofue, Y. (Tokyo)	HI and OH absorption in NGC 3079. 20 cm line.
AI040	Inoue, M. (Nobeyama) Aizu, K. (Rikkyo) Tabara, H. (Utsunomiya) Kato, T. (Utsunomiya) Perley, R.	Two candidate, large rotation measure sources. 6 and 20 cm.
AJ182	Johnston, K. (NRL) Florkowski, D. (USNO) deVegt, C. (Hamberger Sternwarte)	Milliarcsecond positions of radio stars. 3.8 cm.

No.	Observer(s)	Program
AJ183	Jackson, N. (NRAL) Browne, I. (NRAL) Shone, D. (NRAL) Clarke, D. (New Mexico)	Structure and polarization of 0800+608. 3.8 cm.
AJ185	Jannuzi, B. (Arizona) Elston, R. (NOAO)	Structure of X-ray selected BL Lac objects.
AJ186	Johnston, H. (Caltech) Kulkarni, S. (Caltech) Goss, W. M.	Deep imaging of globular clusters. 20 cm.
AJ189	Johnston, K. (NRL) Claussen, M. (NRL) Bowers, P. (NRL)	Distance to IK Tau: motions of water maser components. 1.3 cm line.
AJ191	Jauncey, D. (CSIRO) Jones, D. (JPL) Meier, D. (JPL) Murphy, D. (JPL) Preston, R. (JPL)	Monitoring possible Einstein ring 1830-211. 3.6 cm.
AK226	Kulkarni, S. (Caltech) Phillips, T. (Cornell)	Astrometry of pulsar in W44. 20 cm line.
AK239	Kapahi, V. (TIFR) Subrahmanya, C. (TIFR) Hunstead, R. (Sydney)	Optically deep sample of Molonglo quasars. 3.8 cm.
AK244	Kulkarni, S. (Caltech Johnston, H. (Caltech) Prince, T. (Caltech)	Astrometry of globular cluster pulsars. 20 cm.
AL150	Lestrade, J.-F. (JPL) Preston, R. (JPL)	Statisitical properties of RSCVn stars. 6 cm.
AM285	Mahon, M. (Florida) Gottesman, S. (Florida) Hunter, J. (Florida) Hawarden, T. (Royal Obs.)	Peculiar ellipsoidal galaxy NGC 660. 20 cm line.
AM286	Mantovani, F. (IRAM) Fanti, R. (IRAM) Padrielli, L. (IRAM) Saikia, D. (TIFR)	Steep-spectrum low-frequency variable sources. 2 and 3.8 cm.
AM290	Menon, T. (British Columbia)	Structure of interacting galaxies. 6 cm.

No.	Observer(s)	Program
AM291	Menten, K. (CFA) Reid, M. (CFA) Johnston, K. (NRL) Walmsley, C. M. (MPIfR) Wilson, T. (MPIfR)	Small-scale structure of methanol masers. 1.3 cm.
AM292	Miley, G. (Leiden) Saunders, R. (MRAO) Chambers, K. (Johns Hopkins) Rottgering, H. (Leiden) Rawlings, S. (MRAO)	Finding the most distant galaxies: ultra-steep spectrum sources. 20 cm.
AM293	Mirabel, I. (Puerto Rico) Rodriguez, L. (UNAM) Ruiz, A. (UNAM)	Continuum flux from the OH megamaser galaxies. 20 cm.
AM296	Murphy, D. (JPL) Perley, R.	Flip-flop superluminals? 20 cm.
AM298	Mitchell, D. (Berkeley) de Pater, I. (Berkeley)	Sub-surface imaging of Mercury. 3.8, 6 and 20 cm.
AM299	Muxlow, T. (NRAL)	High resolution, high sensitivity imaging of the quasar 3C 418. 6 cm.
AM308	McHardy, I. (Oxford) Callanan, P. (Oxford) Lehto, H. (Oxford)	Mapping of globular cluster X-ray sources. 3.5, 6 and 20 cm.
AO088	Owen, F. Eilek, J. (NMIMT)	Observations of M87. 3.8 cm.
AO096	Okorogu, A. (Nigeria) Akujor, C. (Nigeria)	Radio jets without hotspots. 3.8 cm.
AO097	Ozernoy, L. (Los Alamos) Gwinn, C. (Calif., Santa Barbara) Morris, M. (UCLA) Yusef-Zadeh, F. (Northwestern)	In search of a nuclear wind from the galactic center. 1.3 cm.
AP170	Perley, R. Taylor, G. Inoue, M. (Nobeyama) Kato, T. (Utsunomiya) Tabara, H. (Utsunomiya)	Very large Faraday rotation in Hydra A. 3.8 cm.

No.	Observer(s)	Program
AP183	Pedlar, A. (NRAL) Axon, D. (NRAL) Baum, S. (NFRA) O'Dea, C. (NFRA) Unger, S. (RGO)	NGC 4151. 3.8 and 6 cm.
AP184	Pedlar, A. (NRAL) Collison, P. (NRAL) Saikia, D. (TIFR) Axon, D. (NRAL) Unger, S. (RGO)	NGC 4321 and a sample of Sersic-Pastoriza galaxies. 3.8 cm.
AP186	Penninx, W. (Amsterdam) van Paradijs, J. (Amsterdam) van der Klis, M. (Amsterdam) Jansen, F. (Leiden) Lewin, W. (MIT)	Z-source GX 340+0. 6 and 20 cm.
AP188	Pooley, G. (MRAO) Rawlings, S. (MRAO) Saunders, R. (MRAO) Warner, P. (MRAO) MacMahon, R. (Columbia)	Quasars from a deep, low frequency survey. 20 cm.
AR208	Rudnick, L. (Minnesota) Anderson, M. (Minnesota) Wang, Y. (Minnesota)	3C 33 north hot spot. 20 cm.
AR216	Reid, M. (CFA) Menten, K. (CFA)	Measurement of the size and temperature of Mira variables. 1.3 cm.
AR220	Reid, M. (CFA) Silverstein, E. (CFA)	OH masers and the galactic magnetic field. 20 cm line.
AR221	Rodriguez, L. (UNAM) Moran, J. (CFA) Curiel, S. (CFA)	A remarkable triple source in Serpens. 3.8 and 20 cm.
AR223	Rudnick, L. (Minnesota) Anderson, M. (Minnesota) Meisenheimer, K. (MPIfA, Heidelberg) Roser, H. (MPIfA, Heidelberg)	3C 33 south hot spot. 2 cm.
AR225	Rucinski, S. (York Univ.)	Close binary ER Vul. 6 and 20 cm.
AR226	Rucinski, S. (York Univ.)	Three T Tauri stars. 3.5, 6, and 20 cm.

No.	Observer(s)	Program
AR229	Ratner, M. (CFA) Lebach, D. (CFA) Bartel, N. (CFA) Shapiro, I. (CFA)	Reference star search for the NASA gyroscope relativity experiment. 3.8 cm.
AR231	Reid, M. (CFA) Menten, K. (CFA)	"Light curves" for Mira variables. 3.8 cm.
AS333	Sramek, R. Weiler, K. (NRL) van der Hulst, J. (Kapteyn Obs.) Panagia, N. (STScI)	Statistical properties of radio supernovae. 2 and 6 cm.
AS393	Saikia, D. (TIFR) Pedlar, A. (NRAL)	Interstellar scattering in the inner galaxy. 3.8 and 6 cm.
AS395	Schmidt, M. (Caltech) van Gorkom, J. (Columbia) Schneider, D. (Princeton/IAS) Gunn, J. (Princeton)	A survey of high-redshift quasars. 6 cm.
AS396	Shastri, P. (Texas) Wills, B. (Texas)	Polarimetric test of the unified interpretation of quasars. 3.8, 6, and 20 cm.
AS401	Sramek, R. Goss, W. M. Cowan, J. (Oklahoma)	Supernova 1970G in M101. 6 cm.
AS402	Strauss, M. (Caltech) Partridge, R. B. (Haverford)	Radio morphology of ultra-luminous IRAS galaxies. 20 cm.
AS404	Stocke, J. (Colorado) Maccacaro, T. (CFA) Gioia, I. (CFA) Wolter, A. (CFA) Morris, S. (Carnegie) Jannuzi, B. (Arizona)	X-ray selected BL Lac objects. 20 cm.
AS405	Su, B. (Yunnan Obs.) Mutel, R. (Iowa)	Ring galaxy NGC 5930. 3.8 and 6 cm.
AT105	Taylor, G. (UCLA) Perley, R.	Spectral index and depolarization of Hydra A. 20 and 90 cm.
AT106	te Lintel Hekkert, P. (Leiden) Zijlstra, A. (Kapteyn Lab)	OH mapping of young stellar objects. 20 cm line.

No.	Observer(s)	Program
AV164	van Breugel, W. (LLNL) Dey, A. (Berkeley) Spinrad, H. (Berkeley) McCarthy, P. (Mt. Wilson)	Misaligned radio galaxies at high redshift. 3.8, 6, and 20 cm.
AV166	Velusamy, T. (TIFR) Venugopal, V. (TIFR)	Composite SNR G18.95-1.1. 6, 20, and 90 cm.
AV174	van Paradijs, J. (Amsterdam) Penninx, W. (Amsterdam) van der Klis, M. (Amsterdam Jansen, F. (Leiden) Lewin, W. (MIT)	Atoll sources GX 9+1 and GX 9+9. 6 cm.
AV175	van Breugel, W. (LLNL) Allington-Smith, J. (Durham)	High resolution maps of two B2/1Jy sources. 3.8, 6, and 20 cm.
AW230	Wrobel, J. Unger, S. (RGO)	International monitoring of the Seyfert NGC 5548. 3.8 cm.
AW248	Wieringa, M. (Leiden) Katgert, P. (Leiden)	Faint, steep spectrum radio sources. 20 cm.
AW249	Wills, B. (Texas) Shastri, P. (Texas)	Core variability in lobe-dominated quasars. 6 cm.
AW252	Whittle, M. (Virginia) Wilson, A. (Maryland)	Jet and ISM interaction in Markarian 78. 2 cm.
AW253	Wilson, A. (Maryland) Tsvetanov, Z. (Maryland)	The Seyfert galaxy NGC 5252. 6 and 20 cm.
AY033	Yin, Q. Heeschen, D. Saslaw, W. (Virginia)	Study of nine likely starburst galaxies. 20 and 90 cm.
AY036	Yusef-Zadeh, F. (Northwestern)	Proper motion of Sgr A west arms. 2 and 6 cm.
AZ044	Zhao, J. (New Mexico) Ekers, R. (Australia Telescope) Goss, W. M. Lo, K. (Illinois) Narayan, R. (Steward Obs.)	Flux density variations caused by RISS in Sgr A. 3.8, 6, and 20 cm.
BB002	Brown, R. Benson, J.	The apparent structure of Sgr A. 1.3 and 6 cm single dish VLB.
BB003	Benson, J. Brown, R.	The megamaser galaxies IC 4553 and III Zw35. 21 and 18 cm line.

No.	Observer(s)	Program
V90-24	Massi, M. (Arcetri)	Periodic star LSI+61303. Phased array MKIII VLB.

E. SCIENTIFIC HIGHLIGHTS

Green Bank

OH Observations of Comet Austin - Pete Schloerb, Lowell Tacconi-Garman, and Mark Claussen detected OH absorption in Comet Austin (1989c1). This comet offered an exceptional opportunity to measure the gas production rate and coma kinematics because its geocentric distance when observed was only 0.25 AU, and the observations occurred shortly after the comet had passed within 0.4 AU of the sun. The radio observations provide much higher velocity resolution than those at any other wavelength band. They therefore contribute significantly to these complementary studies, some of which were carried on simultaneously with the 140-foot observations. The data acquired from Comet Austin can be added to those from Comet Halley and Brorsen/Metcalf to test critically models for OH excitation, production, and kinematics.

Recombination Line Emission from Sharpless 183 - Controversy exists over whether S183 (G123.1+2.9) is an HII region or a supernova remnant. A DRAO synthesis telescope map at 1420 MHz supported the conclusion that it was an HII region, but its angular size was very large (30-40 arcmin). If a recombination line could be found, it would confirm the HII nature of S183. T. L. Landecker, M. D. Anderson, D. Routledge, and J. F. Vaneldik detected the H159α recombination line, using the 140-foot telescope. The radial velocity of the line, however, was truly surprising. It implied S183 was at a distance of several kiloparsecs. Combined with its large angular dimensions, the object seems to be one of the largest HII regions known.

Tucson

Millimeter Wavelength VLBI - In April, the 12-meter participated in an international millimeter-wave VLBI experiment by L. Bååth (Onsala), M. Wright (UC-Berkeley), A. Rogers (Haystack), and others. The project involved observations at λ3 mm, 1 mm, and 6 cm, and included, in addition to the 12-meter, the Hat Creek, Owens Valley, Onsala, Nobeyama, and SEST millimeter wave observatories. The project included observations of a number of quasars with a goal of studying jet components in their early stages of development. Early indications were that the 3 mm portion of the experiment went quite well, although the 1 mm observations were hampered by poor weather. The new 1 mm SIS receiver was used for the observations at the 12-meter telescope.

Structure of the High Latitude Galactic Cloud MBM 53 - L. J Rickard (NRL), F. Verter (USRA - NASA/GSFC), and B. Turner (NRAO) have used the 12 meter to study the CO emission in the high latitude galactic cloud MBM 53. This cloud has a remarkable structure in the infrared, as shown in IRAS data: the cloud appears as a 3° x 5° rectangle surrounding an empty square bay of 2° x 2°. Using 12 meter data, the observers found that the source was very complicated in its velocity structure. The sharp edges of the cloud seen on the infrared plates are also evident in CO emission. Furthermore, the $^{12}CO/^{13}CO$ ratio is found to be uniformly high across the cloud (~12, compared with a more typical value of 4-5 found in other clouds). The observers intend to continue their investigations using the emission from other molecules.

Socorro

VLA Images at 73.8 MHz - First images of the astronomical sources Cas A, the Crab, Cyg A, and Virgo A have been made by N. Kassim (NRL), R. Perley (NRAO), and W. Erickson (Tasmania) in order to test the new VLA 73.8 MHz instrumentation which has now been installed on eight antennas. RFI rejection was successfully accomplished using spectral line observing techniques for data editing. Phase self-calibration techniques were based on source models obtained with the VLA at 90 or 20 cm in the C and D configurations. At the present stage of development, the system provides a synthesized beam of approximately 30" FWHP. The map of Cyg A shows evidence of the steep spectrum bridge of radio emission linking the prominent radio lobes, while in Vir A 73.8 MHz emission is associated with the lobes and is elongated in a direction parallel to the jet. The map of the Crab nebula shows good agreement with a 20 cm VLA map, but there is not yet enough sensitivity at 73.8 MHz to detect the central steep-spectrum pulsar. In general, the maps are approaching the level of resolution (20 arcseconds when fully implemented) where comparison with higher frequency maps will clearly point to significant spatial variations in the spectral index across the source.

New Globular Cluster Pulsar - Observations by A. Fruchter (Carnegie) and W. M. Goss (NRAO) with the VLA have recently led to the discovery of another eclipsing millisecond pulsar in a southern globular cluster. Object PSR 1745-24, located in the cluster Terzan 5, has the very fast period of 11.563 ms and a dispersion measure of 240 cm^{-3} pc. It and its white dwarf companion, however, have the extremely short binary period of 1.7 hours with the pulsar in eclipse for nearly one-half of the orbital period. The companion could be as small as 0.1 solar masses. Terzan 5 was targeted initially by the VLA as containing a steep spectrum continuum source with a mean 20 cm flux density of only 1 mJy. When selected from among numerous candidates, the precise VLA location of the source, only 20 arcseconds from the cluster center, was the key which allowed the pulsar characteristics to be determined with the Parkes 64 m and confirmed at Jodrell Bank.

VLA Imaging of Extragalactic Ammonia: IC 342 - The first successful imaging of ammonia in an extragalactic source has been accomplished by P. Ho (Harvard), R. Martin (Steward), J. Turner (UCLA), and J. Jackson (MPIfR) with the VLA in the spiral galaxy IC 342. Previous single dish studies of NH_3 line transitions had established the existence of a hot gas component in IC 342, but its location, morphology, and dynamics with respect to known CO molecular gas features were unknown. Earlier VLA attempts to study the NH_3 emission had only resulted in upper limits. Making use of the upgraded 1.3 cm VLA receivers and increased processing capabilities of the VLA correlator, however, the new observations improved on earlier noise level sensitivities by more than a factor of two. The VLA D-configuration 5 arcsecond resolution of the NH_3 (J,K) = (1,1) and (2,2) inversion lines produced spectral line maps with a spectral resolution of 19.7 km sec^{-1}. The hot gas traced by the NH_3 emission is found to be intimately associated with known CO structures and the likely source of heating of the NH_3 gas in star-formation activity along the central arm-like features of the galaxy.

F. PUBLICATIONS

Attached as Appendix A is a tabulation of all preprints received in the NRAO Charlottesville library authored by NRAO staff or based on observations obtained on NRAO telescopes during the reporting period.

G. CENTRAL DEVELOPMENT LABORATORY

Amplifier Development

The prototype 12-18 GHz amplifier was built and tested. It was followed by a production of two more amplifiers. Typical noise performance at 14 GHz is 14 K and is less than 20 K from 12 to 18 GHz with a minimum gain of 22 dB.

The noise models for Linear Monolithics (1192A-D) and two GE experimental devices (503-1, 525-1) were established. The work on the 40-45 GHz amplifier using Linear Monolithics devices and soft substrate technology is in progress.

Eleven of the 1.2-1.8 GHz amplifiers and six of the 26-36 GHz amplifiers have been built, tested, and delivered. Three of the 21-25 GHz amplifiers have been refurbished with new devices.

A summary of amplifier deliveries in this quarter is given in the table below:

FREQUENCY BANDS	NUMBER OF AMPLIFIERS	COMMENTS
1.2-1.8	11	
12-18	3	New design
21-25	3	Refurbished with new devices
26-36	6	
Grand Total	23	

Superconducting (SIS) Millimeter-Wave Mixer Development

Work on six new SIS receiver modules for the 12-meter telescope is almost complete. These receivers will cover 68-90, 90-115, and 200-260 GHz, with two polarizations in each band, and will be installed on the 12-meter telescope in the near future.

The 68-90 GHz receivers use a scaled version of the successful 90-115 GHz mixer, and are expected to have comparable overall DSB receiver noise temperatures ($20 \leq T_R \leq 40$ K).

Further testing of $Nb/Al\text{-}Al_2O_3/Nb$ trilayer junctions made at the University of Virginia continues to give excellent results: From 200-260 GHz we have measured an overall DSB receiver temperatures $46 \leq T_R \leq 117$ K. An experimental tunerless 200-

260 GHz mixer has given very encouraging results, and we now hope to be able to use tunerless mixers in the SIS upgrade of the 8-beam, 230-GHz receiver.

The design of a 2-mm SIS mixer compatible with existing SIS devices is almost complete.

The supply of SIS junctions still limits our ability to design new mixers and improve the old ones. The recent success of the UVA niobium mixers and the flexibility of their fabrication process make them an ideal source for development of our new receivers. Unfortunately, the continued survival of the UVA group is in jeopardy because of lack of support.

Collaboration on SIS mixer development continues with UVA, IBM Watson Research Center, and the University of Illinois/UC Berkeley. We shall be having discussions with IRAM this summer to explore the possibility of a collaboration as they develop a niobium-based process for SIS junctions.

During this quarter we have tested a total of 15 SIS mixers operating from 68-260 GHz.

Schottky Diode Millimeter-Wave Mixers and Multipliers

In support of the 12-meter telescope and millimeter-array site testing radiometers, we have built (or re-built) and tested a total of nine Schottky mixers and multipliers in the 230, 300, and 345 GHz bands during this quarter.

Acousto-Optical Spectrometer Project

Work on this project was mostly suspended during the quarter due to lack of manpower. Other work had higher priority. This situation is expected to continue during the next quarter, with work on the AOS scheduled to resume around October 1. At that time, we will continue to experiment with improvements to the optical path, and we will also implement new electronics and software intended to provide a convenient interface to the 12-meter telescope.

H. GREEN BANK ELECTRONICS

Green Bank Telescope

A major project is underway to replace the collapsed 300-foot telescope with a state-of-the-art 100-meter class telescope. The Green Bank electronics division is supplying expertise to the design effort in a few areas. The design of the optics for the telescope is being refined. Surface shape, subreflector shape and positioning, and receiver positioning have been detailed. Components for the active surface, in particular, Linear Variable Differential Transformers (position transducers) and DC gear motors, are currently being tested. The details of a scheme to provide highly accurate pointing, using collimators, mirrors and shielded light beams, are being worked out. A system has been breadboarded to evaluate a laser ranging scheme for surface measurement.

Interferometer Upgrade

The USNO is funding the upgrade of the Interferometer to improve their time-keeping capabilities. As part of this upgrade, the three antennas have been outfitted with cooled S/X receivers. A 610 MHz receiver has also been added to the 85-3 antenna. The 85-3 telescope is operated as a VLBI terminal in conjunction with other USNO antennas and as a single dish pulsar timing antenna. The 85-1 and 85-2 antennas are operated as a connected interferometer to continue a long-term flux monitoring program. Another aspect of the upgrade is the provision of a data acquisition terminal for the VLBI data. This terminal will consist of a VLBA data acquisition rack, longitudinal recorder, and control computer.

Progress was made on several fronts during the past quarter. A 327 MHz receiver for the 85-3 antenna was installed during the quarter. System tests by the Princeton pulsar group are underway. Nine converters for the VLBA data acquisition rack were completed during the quarter. Fifteen more are in various states of assembly and test. All the hardware for the rack control computers is in-house, awaiting software from the VLBA monitor and control group.

140-foot Cassegrain Receivers

The current 140-foot cassegrain receiver systems uses parametric upconverters and 18-25 GHz masers to cover the 5-25 GHz frequency range. A project is underway to replace the upconverters with HEMT amplifiers and to also extend the frequency range to greater than 30 GHz. The masers will be retained because of their significantly superior noise performance over current HEMT technology. The first step in this project is to redesign the LO for frequency flexibility to 35 GHz.

During this quarter testing of components for the LO system and 32 GHz upgrade continued. It is estimated that the upgrade to 32 GHz is 80 percent complete, with completion of this part of the project slated for late 1990.

Spectral Processor

The Spectral Processor is a high time resolution spectrometer capable of producing two 40 MHz spectra, each 25.6 μs. A fair amount of flexibility in terms of bandwidth, number of channels, and averaging time is included to make the instrument useful for spectroscopy. It has special signal averaging capabilities built-in to facilitate its use as a pulsar back-end.

A subsystem consisting of two IF-to-video converters and half of the digital electronics has been in operation for several months. Chassis wiring for all remaining (7) baseband converters has been completed; three of these are completely tested. The final four digital cards for the second half of the system and for spares were tested during this quarter. These will be integrated into the system this summer.

Miscellaneous

One S-band and one C-band VLBA receiver were completed, with a second S-band well underway. Construction of the 2-16 GHz VLBA local oscillators was delayed in order to put some effort into the 43 GHz VLBA receivers. The first of these receivers was assembled during the quarter and testing on it has commenced. The performance of the

300-1000 MHz receiver was enhanced by the addition of 800 MHz HEMTs. Performance parameters were not available at press time.

I. 12-METER ELECTRONICS

1.3 mm Receiver

As reported previously, a new 1.3 mm SIS dual-polarization receiver is being developed for the 12-meter telescope. The first telescope tests of this receiver with its closed cycle cryostat took place in April. The new SIS system was used for 1.3 mm VLBI observations which took place in April. From the experience gained in these tests some refinements are being made to the receiver, which will be available for regular observing this fall. We anticipate a receiver noise performance of below 200 K SSB over the range 200 GHz to 250 GHz. Observers may propose for this receiver now.

This 1.3 mm receiver is the first of a new generation of SIS receivers for the 12-meter which will eventually cover all the atmospheric windows from 70 GHz to 370 GHz. We expect some of these receivers to be available for use in the coming observing season. When these receivers become available for proposals, we will announce the fact in the Newsletter or through direct mailings.

Holography

In 1987 and in 1988 we performed holography measurements of the 12-meter telescope. From those measurements a shaped subreflector was produced which partially compensated for the imperfections of the primary 12-meter surface. This work was done in collaboration with Charlie Mayer and John Davis at the University of Texas. The result was that the 75 micron rms surface error of the primary became, in combination with the shaped subreflector, equivalent to a surface with 55 micron rms error, giving an increase of approximately 60 percent in telescope efficiency at 350 GHz. This has been reported in earlier newsletters.

During 1989 we experienced a gradual deterioration in pointing characteristics of the 12-meter telescope, with some hysteresis effects. During our investigation we found two weak points in the telescope structure, where steel members had been bolted but not welded. There was evidence of slight relative movement of the structure as a function of elevation, which had in fact been responsible for our gradual deterioration in pointing precision. During the summer shutdown of 1989, these and other points of the backup structure were welded together. The result is a stiffer telescope surface, but with a slight change in the profile of the primary.

In April of this year we undertook some more holography measurements, to measure by how much the primary surface profile had changed. The agreement in small-scale (< 2 meters) features of the surface between the new 1990 measurements and the 1988 data is excellent, but the large-scale astigmatic term has changed significantly. Again in collaboration with Charlie Mayer and John Davis, we intend to produce a new shaped subreflector for the 12-meter telescope, matched to the changed 12-meter primary surface profile. We hope to have this new subreflector on the telescope before the next high-frequency season.

Owing to a number of factors, including improvements in stability of the 38 GHz holography receiver, and the availability of more precise LES8 satellite ephemeris predictions, we believe that the latest holography measurements are of higher quality than before. We are hopeful of bringing the effective surface inaccuracy of the 12-meter telescope down below 50 microns with the newest shaped subreflector.

Telescope Control System

Tests of the new 12-meter telescope control system ("Cactus") were made in June. The two main aspects of these tests were: (1) A quantitive comparison of Cactus and Forth, looking for any systematic pointing differences. Measurements were made using the optical telescope system, overnight when the temperature should be stable, and with Cactus and Forth measurements separated by less than about two hours.

A fit to the pointing residuals, derived from observations of up to 50 stars both with Forth and with Cactus, showed that any systematic differences in pointing between the two systems are below 1 arc sec.

(2) Synchronization of data acquisition and telescope control. We were able to make standard "5-point" radio pointing measurements, on planets and on a quasar, with data being written in standard POPS format and analyzed by the standard CONDAR data reduction program. The Cactus radio pointing derived this way was in excellent agreement with Forth radio pointing. This test used the new 8-channel digital continuum backend, thus testing both new hardware and software.

The new control system monitor task was used throughout these measurements, giving monitor displays equivalent to the old Forth monitor screens. The control system user interface for these tests was a "script" file which defined the observing procedure. This interface is intended strictly for engineering tests at this stage; the real user interface part of the system is still under development. The next control system test will take place in mid-July, and will test cooordination of spectrometer data acquisition with telescope control.

J. VLA ELECTRONICS

Improvements in Antenna Pointing

Antenna pointing errors degrade the performance of synthesis telescopes at both low and high frequencies. At low frequencies strong background sources are randomly located in the primary beam and pointing errors then limit the achievable dynamic range. At high frequencies the pointing errors become a significant fraction of the primary beamwidth so the source being imaged is affected directly. For example, at 44 GHz a 20" pointing error causes a 30 percent change in amplitude. Solar-induced tilts, which used to dominate our pointing errors, have been greatly reduced through external insulation of the antenna yoke and base support.

An important pointing problem being investigated now is the occurrence of tilts of up to 20 arcseconds on the azimuth axis of a few antennas at certain azimuth angles. This effect is believed to be caused by deformations or perturbations in the azimuth bearings. This, and other problems such as an antenna tilt caused by constant wind force, could be corrected in the future by an active correction scheme utilizing electronic tilt-meters mounted on the antenna structure. Testing of the stability of the redesigned tilt-meter units show a long-term stability of about 3 arcseconds. Eight have been fabricated and tested. Two VLA antennas have been outfitted with two sets of tilt-meters on each antenna. Engineering testing of these four units installed on the antenna are complete. In order to provide more information about these antennas, plans are underway to instrument 32 temperature probes at various locations on these antennas by the last quarter of 1990. Further system testing will continue through 1990.

RFI Improvements

The sensitivity of the 327 MHz and 75 MHz systems will be limited partly by radio-frequency interference locally generated at each antenna. Modifications to various modules to reduce this interference and increase the instantaneous usable bandwidth were investigated. A modification to allow the monitor and control system to free run eliminated most of the coherent RFI between antennas. However, the remainder still limits use of the 327 MHz system, so enclosing the radiating components with RFI shields is necessary.

Four prototype RFI enclosures for the vertex mounted "B" racks have been installed and tested. These RFI enclosures eliminate the remaining antenna-generated interference at 327 MHz. There is still some locally generated RFI noticeable at 75 MHz. The remaining twenty-four RFI enclosures have not been procured due to an increase in cost by a factor of two. An in-house design for a new RFI enclosure is almost complete. Material for a prototype unit has been ordered. Construction will start in the third quarter of this year.

1.3-1.7 GHz T_{sys} Improvements

HI imaging is the most important class of spectral line project at the VLA. The observation of HI in emission (either galactic or extragalactic) is almost always sensitivity limited, either because the HI has to be followed to the faint outermost regions of galaxies or because more angular or frequency resolutions are desirable.

The VLA 18-21 cm wavelength feed currently has system temperatures of approximately 60 K. A significant fraction of this system temperature results from the need to locate all front-ends in the same cryogenic dewar. This results in polarization splitters from being cooled.

For example, using cryogenically cooled HEMT amplifiers on the fully optimized VLBA antennas, the measured system noise temperature is 30 K at 18-21 cm. Although some effects, such as subreflector diffraction, will prevent VLA noise temperatures from ever being quite as low as these VLBA values, a VLBA front-end installed on a VLA antenna gave a system temperature of about 35 K.

A project to install VLBA-style 18-21 cm front-ends on all of the VLA antennas is now underway. Two of the new front-end systems are now in the assembly process. By the end of this year, five VLA antennas should have the improved VLBA-style receivers.

High Time Resolution Processor

We are currently instrumenting the VLA with a high time resolution processor (HTRP). The system will be used for observations of time varying phenomena like flare stars, pulsars, etc., and for monitoring radio frequency interference (RFI). The system utilizes existing components such as the VLA analog sum phased array outputs and the VLBI MK III IF-VIDEO converter system which serves as a set of tunable filters with selectable bandwidths. This provides 14 pairs of RCP and LCP frequency signals from the phased array VLA. Total power detector and cross multipliers are used to measure all four products with integration periods of 25 microseconds to 5 milliseconds. The data acquisition system is a 64-channel multiplexer and a 12-bit analog to digital converter with maximum sampling rate of 100,000 samples/sec. This is installed on a 386-based personal computer with a 20 MHz clock and a 140 MB hard disk. The data acquisition system has been used to obtain 2-channel phased array VLA signals for developing software and understanding the system stability problems. The bench testing of the 64-channel system is complete. Array testing will start during the next quarter.

K. AIPS

The AIPS group has attempted to develop some form of quality control over the quarterly releases. We now freeze the code one month before the nominal release date and perform our normal update procedures. We then do a test installation ourselves for both the Unix and VMS versions and run the code verification (the so-called DDT) package. We hope that this new procedure will remove the problems we had with the 15OCT89 and 15JAN90 releases.

A new version of the AIPS cookbook is almost available to users. It should be printed in early August. Major modifications have been made to reflect the huge changes made to AIPS since the previous edition of the cookbook was published. The calibration tasks are comprehensively described, as are the new tasks for self-calibration and imaging.

The calibration package itself is now fairly mature and most changes now made are of the form of minor bug fixes. This leaves the group free to work on new developments. Most work has been done on applications for VLBI, specifically on a task to read data from VLBI MkIII correlators and an interactive editor for VLBI-type data. Images can now be made from visibility data without having to sort them. This has resulted in much greater convenience for users.

L. VLA COMPUTER

The Solbourne Unix file server has been installed. This file and compute server is called ZIA and will replace VAX3 later this summer. User accounts, including E-mail, will be moved from VAX3 to ZIA. The plan is to drop hardware maintenance on VAX3 by August and to disconnect VAX3 in September. The exact schedule depends on how successful we are in moving user accounts from VAX VMS to unix. In addition, a postscript printer is now available to our Unix systems. This printer has been used with standard programs such as TeX, AIPS, SMONGO and PGPLOT. VLA computing continues to move towards such industry standards as Unix, Postscript and X-windows. The Solbourne also supports an

8 mm cartridge tape drive. While this system is primarily used for system backups, it can be used for data exchange using 8 mm cartridge tapes.

The online ModComp system can now produce spectral line polarization data. This new observing mode has been tested and will soon be available for general use. A ModComp program to translate older ModComp archive tapes into the new archive format has been written.

The PC version of OBSERVE is available. Several copies were distributed at the Users meeting in June. The current PC OBSERVE supports a limited number of sources and does not yet do report generation. Work continues on a Unix version of OBSERVE, and it will be available next quarter. Future enhancements to the program will include solar observing, VLBA support, and an X11 windows interface.

M. VERY LONG BASELINE ARRAY

Antennas and Site Preparation

"First light" was obtained on May 22 at the North Liberty, IA antenna, utilizing the 20 and 6 cm receivers. Pointing and other start-up tests will resume after antenna painting is complete in the near future. The old University of Iowa antenna at North Liberty is being disassembled. With first light at this fifth antenna of the VLBA, half of the array is now operable to at least some limited degree. The Pie Town, Kitt Peak, and Los Alamos antennas participated in the Mk II observations of the June VLBI Network session at 1.3, 3.6, and 6 cm. Pie Town also supported many of the Mk III observations. Pie Town continues to support some NASA/GSFC Crustal Dynamics observations, typically monthly, and the operable part of the array supports occasional non-Network observations.

Mechanical and electronic outfitting of the Owens Valley antenna is underway, and scheduled for completion in the fourth quarter. The Brewster, WA antenna is complete except for punch-list items and pointing, and awaits outfitting, scheduled to start the fourth quarter of this year. Site construction was restarted in St. Croix, VI in June. Legal counsel for NRAO and the opposing land developer have been negotiating to find ways to prevent further opposition. Site acquisition of the Mauna Kea, HI location has progressed to the right of entry. The construction plans for Mauna Kea have been approved by all local authorities. A construction bid package was released to bidders on 18 June, with a construction contract award expected in August.

Electronics

The first 2.3 GHz front end of the modified design using the larger capacity refrigerator (CTI model 350) was installed in May on the Pie Town antenna, and was checked out as satisfactory. Construction of the first 43 GHz front end at Green Bank is almost complete, and laboratory testing will commence about the end of June. This unit is scheduled for installation on the antenna at Pie Town in September. Rack set Serial No.8 is being tested as the quarter ends, and is due for installation at Owens Valley in mid-July. Construction of racks and modules is proceeding essentially on schedule, and orders of metal parts and electronic components for the 1990 construction have almost all been received.

In the electronics area the only unit that is significantly limiting interim operations is the baseband converter. This situation results largely from the desire of users to use eight baseband channels per antenna to increase compatibility with Mark III systems. This is twice the number initially planned for operation at this stage. In addition, the baseband converters have proved to require more manpower to construct and adjust than most other VLBA modules, and delivery times for some of the close-tolerance components needed in this particular unit have been very long. To remedy the situation, a second construction group for baseband converters is being set up in Socorro, and should start production early in the next quarter. By the end of 1990, constraints resulting from availability of baseband converters should be substantially relieved.

Data Recording

The first four production recorders have been delivered to VLBA sites: Pie Town (a second), Kitt Peak, Los Alamos and Fort Davis. The remainder are expected to be shipped one every two weeks as they proceed through final checkout. Assembly work is underway at Haystack on a second production run of eight recorders. One of these is scheduled for a one year loan to the Astro Space Center in the USSR to allow their staff to develop the necessary interfaces to ground stations for the Radioastron satellite, as well as earth based VLBI antennas in the Soviet Union.

Orders are being placed for significant field test quantities of thin-base recording tape with each of three competing vendors: Sony, Maxell, and Ampex. Shipments are expected in the fourth quarter. Among other tests, it is expected that they will be mixed into VLBI and JPL/GSFC Network tape supplies for participating observatories and processing sites. Durability and magnetic mechanical performance will be carefully monitored and analyzed before deciding in 1991 on the supplier of the larger, operational quantities of tape.

Monitor and Control

During second quarter 1990 our primary concern has been with the conversion of the array control software to run under the VxWorks operating system. We have had communications difficulties which have made operations at Pie Town very slow to come on line. We now have a leased line from the VLA site to Pie Town with a Racal 3222 Leased Line Modem, connecting to the AOC by way of a statistical multiplexer. We now have satisfactory work-arounds for the remaining problems, which include: 1) An apparent problem with the modem firmware and/or the RS 232 hardware flow control arrangements, which precludes using the error correction facilities of the modem (workaround: use the modem in "dumb" mode). 2) An apparent problem with the VxWorks networking software that precludes using the nfs protocol for transmitting files from the SUN to the stations (workaround: use rpc protocol for large files, but doesn't work with 2400 baud modems, apparently because of a timeout, and will not work for very large files - 1MByte or so). 3) The nfs protocol apparently involves an unacceptably high overhead in the mode which we were planning to use it for--transmission of logging data back to the SUN (workaround: use a socket-to-socket protocol instead, with our own server).

We have essentially completed the software for support of the tape transport and formatter. There remain a few stand-alone programs, written under VersaDos, that have not yet been converted to run under VxWorks. (For example, tiltmeter data collection, antenna servo performance, holography scanning).

We have begun work on the system software for the MVME 147 CPU board, with which we shall eventually replace the MVME 121 boards currently in use in the station computers.

The next station to be converted to the VxWorks operating system will be Los Alamos. It will be connected via ethernet to an Internet router, rather than using the SLIP communications protocol. The appropriate hardware and telephone lines have been ordered to effect this connection. A similar connection probably will be arranged for Kitt Peak.

Correlator

Tests using the 40 prototype "FX chips" received in March dominated the correlator hardware effort during this quarter. These tests have now confirmed convincingly the initial indications that the current prototype version meets NRAO's specifications, and simultaneously have verified substantially the performance of the two major modules which use the FX chip. Functions tested include the basic FFT and cross-multiply operations, the various multi-processing modes, and the linear components of fringe rotation and fractional-sample correction. On the basis of these results, NRAO approved the FX chip prototype on June 1. Production of the full 3200-chip order awaits final negotiation of terms and conditions with LSI Logic Corporation, which was not complete at the quarter's end.

In parallel, tests of the FX chip prototypes have also verified the design and layout of the multi-layer printed-circuit boards used for the FFT and multiplier/accumulator modules. A small number of changes will be necessary in the former; the latter has been approved and fabrication in quantity authorized.

The correlator software team concentrated its efforts on development of the real-time control code throughout this quarter. With the construction of several new software modules, it has become possible to integrate much of the extensive code previously completed into a coherent real-time nucleus. Correlation "jobs" can be loaded from the intermediate script which serves as the interface from the DBMS-based high-level control sub-system, and are initiated by a (currently) rudimentary job-control task.

Data Processing

The bulk of the software needed for the normal processing of astronomical data from the VLBA is currently available and in routine production use. There are three general areas which need to be developed: 1) the interface to the correlator and monitor data base, 2) calibration and editing of correlator output and 3) geometric analysis of the data (i.e., astrometry and geodesy).

Discussions have been initiated between the correlator group and the data processing group to explicate the details of the format of the data to be exported from the VLBA correlator. Software development this quarter consisted of debugging of editing and spectroscopic calibration functions and the development of a new graphical, data editing tool. A considerable effort and some progress has been made in the processing of MkIII VLBI data for both continuum and spectroscopic data. The MkIII data is very similar to VLBA format data.

N. PERSONNEL

New Hires

Masterman, M. F.	Electronics Engineer I	05/29/90
Hagen, J. R.	Sci. Programming Analyst	04/23/90
Garwood, R. W.	Asst. Scientist, Research Support	05/02/90
Cotter, T. G.	Electronic Engineer I	05/01/90
Weadon, T.	Electronic Engineer I	06/18/90
Milner, M. R.	Systems Analyst	06/04/90
Parker, D.	Electronics Engineer I	06/28/90

Terminations

Price, R. M.	Visiting Scientist	04/15/90

PREPRINTS RECEIVED, APRIL - JUNE 1990

ANANTHARAMAIAH, K.R.; PEDLAR, A. A Wide Field lambda 90cm Image Around the Galactic Centre - Evidence for a Poloidal Magnetic Field.

BASTIAN, T.S. Radio Emission from Flare Stars.

BIRETTA, J.A.; OWEN, F.N. Velocity Structure of the M 87 Jet: Preliminary Results.

BIRETTA, J.A.; STERN, C.P.; HARRIS, D.E. Radio, Optical, and X-ray Observations of the M87 Jet and Nucleus.

BREGMAN, J.N.; ROBERTS, M.S. HI in the Giant Elliptical Galaxy NGC 4406.

BRIDLE, A.H. The Dark Side of Radio Jets in Powerful Extended Sources.

BROWN, R.L. 3C 196: The Jets That Are Not.

CARIGNAN, C.; PUCHE, D. HI Studies of the Sculptor Group Galaxies.

CARIGNAN, C.; PUCHE, D. HI Studies of the Sculptor Group Galaxies. II. NGC 7793.

CARIGNAN, C.; PUCHE, D. HI Studies of the Sculptor Group Galaxies. IV. NGC 247.

CARPENTER, J.M.; SNELL, R.L.; SCHLOERB, F.P. Molecular Clouds Associated with Luminous Far-Infrared Sources in the Outer Galaxy.

CARRAL, P.; TURNER, J.L.; HO, P.T.P. 15 GHz Compact Structure in Galactic Nuclei.

CAYATTE, V.; VAN GORKOM, J.H.; BALKOWSKI, C.; KOTANYI, C. VLA Observations of Neutral Hydrogen in Virgo Cluster Galaxies. I. The Atlas.

CHAMBERS, K.C.; MILEY, G.K.; VAN BREUGEL, W.J.M. 4C41.17—A Radio Galaxy at a Redshift of 3.8.

CLANCY, R.T.; MUHLEMAN, D.O.; BERGE, G.L. Global Changes in the 0-70 km Thermal Structure of the Mars Atmosphere Derived from 1975-1989 Microwave CO Spectra.

CLARK, F.O. Young Stellar Objects Detected by IRAS.

DEY, A.; VAN BREUGEL, W.J.M.; SHIELDS, J.C. Radio Loud Far-Infrared Galaxies.

FINDLAY, J.W. The Calibration Horn Antenna.

FRAIL, D.A.; WEISBERG, J.M. A Critical Evaluation of Pulsar Distance Measurements.

GARAY, G.; RODRIGUEZ, L.F. The Compact Molecular Core Toward G34.3+0.2: VLA Observations in the (2,2) and (3,3) Lines of Ammonia.

GORDON, M.A.; WALMSLEY, C.M. An Observational Study of Millimeter-Wave Recombination Lines.

GREGORY, P.C.; CONDON, J.J. The 87GB Catalog of Radio Sources Covering 0 deg < delta < 75 deg at 4.85 GHz.

GRIFFITH, M.; LANGSTON, G.; HEFLIN, M.; CONNER, S.; BURKE, B. The Fourth MIT-Green Bank 5 GHz Survey.

GRIFFITH, M.; LANGSTON, G.; HEFLIN, M.; CONNER, S.; ET AL The Third MIT-Green Bank 5 GHz Survey.

HJELLMING, R.M.; STEWART, R.T.; WHITE, G.L.; STROM, R.; ET AL Radio and X-ray States in the X-ray Binary Sco X-1.

HUMMEL, E.; DAHLEM, M. The Magnetic Field in Edge-On Galaxies.

HUNTER, D.A.; THRONSON, H.A. JR; WILTON, C. Small Galactic HII Regions. II. The Molecular Clouds.

JEWELL, P.R.; SNYDER, L.E.; WALMSLEY, C.M.; WILSON, T.L.; GENSHEIMER, P.D. Observational Properties of v=1, J=1->0 SiO Masers.

KERR, A.R.; PAN, S.-K. Some Recent Developments in the Design of SIS Mixers.

KOO, B.C.; REACH, W.T.; HEILES, C.; FESEN, R.A.; SHULL, J.M. Detection of an Expanding HI Shell in the Old Supernova Remnant CTB 80.

LIU, R.; POOLEY, G. Radio Polarization and the Environment of 3C 275.1.

LOCKMAN, F.J. Recombination Lines and Galactic Structure.

LOREN, R.B.; WOOTTEN, A.; WILKING, B.A. Cold DCO+ Cores and Protostars in the Warm rho Ophiuchi Cloud.

MANGUM, J.G.; WOOTTEN, A. Observations of the Cyclic C3H Radical in the Interstellar Medium.

MANTOVANI, F.; SAIKIA, D.J.; BROWNE, I.A.W.; FANTI, R.; ET AL The Steep-Spectrum Low-Frequency Variable Source 3C99: Radio and Optical Observations.

MCNAMARA, B.R.; BREGMAN, J.N.; O'CONNELL, R.W. H I Absorption Toward Cooling Flows in Clusters of Galaxies.

NEFF, S.G.; HUTCHINGS, J.B.; STANFORD, S.A.; UNGER, S.W. NGC 1614: An IR-Luminous Merger But Not (Yet?) an Active Galaxy.

O'DEA, C.P.; BAUM, S.A.; STANGHELLINI, C.; MORRIS, G.B.; ET AL Multifrequency VLA Observations of GHz-Peaked-Spectrum Radio Cores.

PEDLAR, A.; GHATAURE, H.S.; DAVIES, R.D.; HARRISON, B.A.; ET AL The Radio Structure of NGC1275.

PORCAS, R.W.; FLATTERS, C.; OWEN, F.N. Very Weak Cores of Extended Quasars.

PUCHE, D.; CARIGNAN, C. Kinematical Study of Groups of Galaxies.

RODRIGUEZ, L.F.; LIZANO, S.; CANTO, J.; ESCALANTE, V.; MIRABEL, I.F. VLA Observations of High-Velocity H I Associated with the Herbig-Haro Objects 7-11.

SAHAI, R.; WOOTTEN, A.; CLEGG, R.E.S. CO in the Bipolar Planetary Nebula NGC3132.

SEAQUIST, E.R.; BELL, M.B. Molecular Absorption by the Dust Lane and Nuclear Region of Centaurus A.

SKINNER, S.L.; BROWN, A.; LINSKY, J.L. New Radio Detections of Early-Type Pre-Main Sequence Stars.

STANGHELLINI, C.; BAUM, S.A.; O'DEA, C.P.; MORRIS, G.B. Extended Radio Emission Associated with GHz-Peaked-Spectrum Radio Sources.

TINNEY, C.G.; SCOVILLE, N.Z.; SANDERS, D.B.; SOIFER, B.T. Molecular Gas in Intermediate Luminosity IRAS Galaxies.

TURNER, B.E. Detection of Doubly-Deuterated Interstellar Formaldehyde (D2CO): An Indicator of Active Grain Surface Chemistry.

TURNER, B.E. A Molecular Line Survey of Sgr B2 and Orion(KL) from 70 to 115 GHz. II. Analysis of the Data.

VAN DER WERF, P.P.; GOSS, W.M. High Resolution HI Observations of HII Regions: II. HI and the Magnetic Field Near W3.

VAN DER WERF, P.P.; GOSS, W.M. Sub-Parsec Size HI Cloudlets Associated with Orion A.

WALKER, C.; CARLSTROM, J.E.; BIEGING, J.H.; LADA, C.J.; YOUNG, E.T. Observations of the Dense Gas in the IRAS 16293-2422 Outflow System.

WILKING, B.A.; BLACKWELL, J.H.; MUNDY, L.G. High-Velocity Molecular Gas Associated with Cold IRAS Sources.

WROBEL, J.M. Active Nuclei and Star Formation in E/S0 Galaxies.

WROBEL, J.M. Active Nuclei in Nearby Elliptical Galaxies.

WROBEL, J.M.; KRAUSE, S.W. Counts of Serendipitous 6 Centimeter Sources in E/S0 Galaxy Fields.

YIN, Q.; HEESCHEN, D.S.; SASLAW, W.C.; HUANG, Z. VLA Observations of the Peculiar Interacting Galaxies NGC 7463-7464.

ZENSUS, J.A. The Compact Radio Jet in the Quasar 3C 345.

ZENSUS, J.A. VLBI Imaging of the Quasar 3C 345 at 43 GHz.

ZENSUS, J.A.; UNWIN, S.C.; COHEN, M.H.; BIRETTA, J.A. The Milliarcsecond Structure of 3C 273 at 22 GHz.

ZHOU, S.; EVANS, N.J. II; BUTNER, H.M.; KUTNER, M.L.; ET AL Testing Star Formation Theories: VLA Observations of H2CO in the Bok Globule B335.